Development of Ultra-low Noise nanoSQUIDs using FIB for Quantum Measurement

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The demands of quantum metrology and nanoscience are driving the requirements for single particle detection capability across a wide variety of physics, including QIP, single photon detection, NEMS, nanomagnetism and spintronics. NanoSQUIDs represent a new manifestation of an old but exciting superconducting technology which addresses some of these requirements. We have fabricated different types of Nb nanoscale SQUIDs with loop size down to 100nm using nanobridge weak-links (∼50nm) as Josephson junctions, utilising a relatively simple FIB-based approach. These devices show non-hysteretic IVCs and very low noise even at operating temperatures at 4.2K and above (white noise at 1kHz ∼ 0.2 $\mu\Phi_0/\mathrm{Hz}^{1/2}$ at 7K). A single nanomagnetic particle e.g. PtFe bead and NEMS resonator have been incorporated into the nanoSQUID system using micro/nano manipulation and FIB techniques. The performance of prototype devices will be described for applications such as energy resolving single photon detection, nanoparticle spin detection [1] and NEMS resonator readout [2].

[1]L. Hao *et al. Appl. Phys. Lett.*, **98**, 092504 (2011)
[2]L. Hao, J. Gallop *et al*, *IEEE Trans. Appl. Supercond.*, **19** (3), 693-696 (2009)